NATURAL VIBRATIONS OF ASEISMIC BOX SHEAR-WALLS

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SUMMARY

The natural vibrations modes and frequences of aseismic box shear-walls are determined by the discretization of the continuum in finite rectangular elements and using the frontal solution method.

The equivalent continuum method is then used with different idealizations, in order to reduce the computer time and simplify their assembly with framed structures.

Finally, trough a case-study comparison is made of the two alternativ methods.

INTRODUCTION AND AIM OF THE INVESTIGATION

The large stiffness possessed by box-shaped shear-walls suggested their increasing use as stiffening systems coupled with framed structures.

The analysis of such systems, approached by the F.E.M., leads to the following problems:

- the elevate number of degrees of freedom requires methods of optimal solutions with respect to the computer times;
- the presence of elements having different degrees of freedom and corresponding representing matrices of different order requires accurate assembling of these matrices.

Both aspects may be overcome by more semplified analytical idealizations, i.e. equivalent continuum methods, which resolves the above problems, provided the actual equivalence is respected.

The natural vibration modes and frequences are then approached by two alternative methods:

- F.E.M., and with frontal solution method;
- equivalent continuum methods with their different idealizations.

The paper describes an automatic computarized method of dinamyc analysis of box-shaped shear-walls for mini-computers, and also a simplified method of analysis.

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PROPOSED F.E.M. APPROACH

The computer program is based on mathematical algorythms semplifying the matrix operations; however the times of computer run are still high.

The procedure can be summarized as follows:

- rectangular elements and similar, are grouped;
- assembling of the K_T (global stiffness matrix);
- Cholevskj method of solution;
- search of eigenvalues and eigenvectors by simultaneous matrix iteration,by matrix condensation.

The computer program permits to analyse models with distributed and concentrated mass.

EQUIVALENT CONTINUUM APPROACH

Referring to case of distributed masses the flexural and torsional vibration are separately treated.

The flexural vibrations are determined, first disregarding the shear deformations, by the following approaches:

a) - solution of the differential equation of motion (natural vibration) by integration;

b) - Rayleigh method;

c) - F.E.M.

If the shear deformation is accounted for, the b) and c) methods only are used.

The torsional vibrations are finally determined with the c) approach only.

Refferring to case of concentrated masses we proceed only by F.E.M.

APPLICATION AND COMPARISON

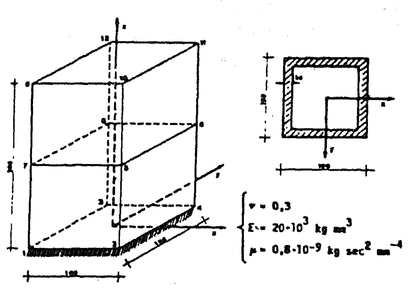

Fig.1

All the above methods are applied to a box--shaped shear-walls (Fig.1), having hollow square-type cross section and fixed at the bottom, considering distibuted masses; the results for the natural frequencies, are summarized in the following table 1.

In order to accept the behaviour of structures with concentrated masses we consider the model of Fig.2.

In the Fig. 3 is reported the convergence diagramm:frequence-F.E.numbers. Only two F.E. were adopted for the analysis of the structure idealizated as beam,

Tabella 1

DYNAMIC ANALYSIS		FLEXURAL FREQUENCIES (1)		TORSIONAL FREQUENCIES (1)
		WITHOUT SHEAR DEFORM	WITH SHEAR DEFORM	
EQUIVALENT CONTINUUM METHOD	DIFF. EQUAT. INTEGRATION	14.795	———	———
	RAYLEYGH	14.859	11.842	———
	F.E.M.	14.143	11.232	22.535
BOX-SHAPED SHEAR WALL		12.892		22.253

(1) Units are $sec.^{-1}$

The results for the natural frequencies, are summarized in the collowing table 2.

Tabella 2

DINAMIC ANALYSIS	FLEXURAL FREQUENCES (1)		TORSIONAL FREQUENCES (1)
	WITHOUT SHEAR DEFORM	WITH SHEAR DEFORM	
EQUIVALENT CONTINUUM METHOD	31,78	30,41	104,55
BOX-SHAPED SHEAR WALL	30,84		107,43

(1) Units are $sec.^{-1}$

CONCLUSIONS

- The F.E.M. gives results very close to well known theoretical methods and can be then adopted for dynamic analysis of the models, idealizated as beam, either with distributed masses, or concentrated ones.
- The comparison of the results shows the corrispondence of the model idealizated as beam, as the analysis of the model Fig.1 has been bounded to eight F.E. and besides, it represent the limit-case of a short box cantilever (height to side ratio 2).
- As for computer time, we observe the

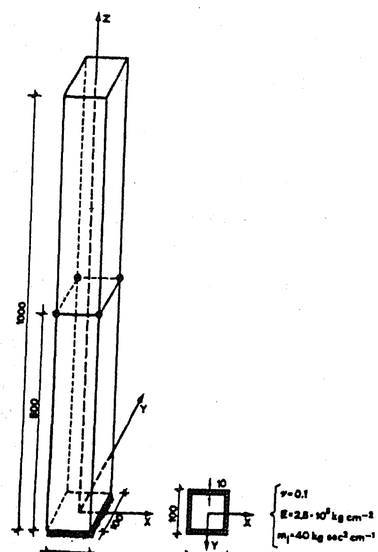

FIG. 2

remarkable advantage of semplified model; this advantage for the examined models is about 1 to 200.

- Besides it is very remarkable the reduction the storage dimension.

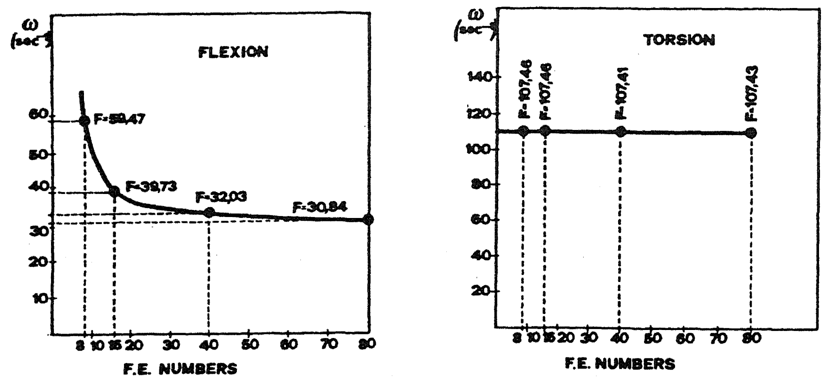

FIG.3

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